

Measuring Effectiveness of Theater IW/C2W Campaigns

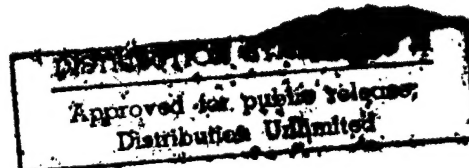
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ABSTRACT

The increasing incorporation of Information Warfare (IW) and Command and Control Warfare (C2W) into theater operations requires some new and original thinking on measures of effectiveness. Whether in training simulations, or simulations conducted as part of the "wargaming" phase of actual operations, measures of effectiveness (MOEs) are required that reflect the nature of theater and Joint Task Force (JTF) operations to assist the commander in planning and executing his operation.

Dynamics Research Corporation (DRC) has worked in the area of theater campaign simulation for a number of years. Working in conjunction with The National War College and The Army War College, DRC developed measures including:

- How well Blue reads the threat plan, to include whether the enemy's main effort was predicted and if it was predicted in a timely manner.
- Whether the Blue force reserves were in the proper location and posture when needed.
- Whether the Blue force commander exploited an asymmetrical advantage and denied the enemy the converse.
- Whether the phasing of the campaign or major operation was properly planned and executed.
- Whether the enemy center of gravity was properly identified, successfully attacked.
- Whether the enemy was defeated, and whether the enemy was convinced of this decision.
- Whether the Blue force components were maintained in a balanced fashion (as opposed to unequal attrition to a marked and unnecessary degree).
- Whether significant modalities (i.e., air, air defense, C⁴I) were defeated on either side
- Whether the theater boundaries were of the proper size to allow the Joint Force Commander (JFC) control of required territory and forces without excessive responsibility for non-essential forces and area.

Success in theater and JTF campaigns demands the full incorporation of C2W and IW. This exploratory paper discusses measures with a commentary on IW, including techniques for selecting theater-level measures and thoughts on modeling and simulation.

I. INTRODUCTION

The end of the cold war and the birth of the new world order — with its new emphasis on Joint, coalition, interagency, and international operations and frequent Operations Other Than War (OOTW) — brought several significant changes in the way the US prepares to wage war:

- The joint system has matured under the power granted by Goldwater–Nichols, and Theater Commanders in Chief (CINCs) are making great use of their new ability to tailor joint task forces (JTFs).
- The Joint Staff, supported by the Services and CINCs, are in the midst of significant developments of joint training and doctrine.
- US Atlantic Command (USACOM) now controls almost all Service combat forces in the continental US. As the Joint Force integrator, USACOM is responsible for the training and deployment of Joint Task Forces.
- We are in the Information Age. While the Persian Gulf war highlighted the power of destroying an opponent's command and control structure, we are only beginning to tap the potential of information supremacy. The Services and the joint system are busily engaged in developing doctrine, tactics and organizations to wage information warfare. Since Information Warfare (IW) will be a key factor in theater operations, we need to be able to measure its contributions

This effort, which addresses measures of effectiveness for theater operations, is a continuing commentary on how the senior commander of a military operation pulls all these things together and how IW and Command and Control Warfare (C2W) supports the theater campaign. It is one of 15 topics covered in our Theater Campaign research note [8]. There are more questions than answers, as we will see.

The paper first establishes some groundwork in the Background section, which presents the concepts of theaters, levels of war, levels of command, OOTW, and sources. Next, IW and C2W are discussed. The Measurement section examines the concept of measuring, looking at "what, when, how" to measure, and subjective versus objective measures. Examples of theater-level measures of effectiveness (MOEs) are provided in the following section, Theater MOE, in which the Theater-Level MOE Worksheet is introduced. Modeling is addressed in the next section, which states why models are of interest, suggests improvements, and discusses worksheet applicability. Finally, we present suggestions for improving the measurement of theater-level C2W.

It is our intent to provide, for policy makers as well as commanders, some techniques for them to measure the effectiveness of their campaigns and operations.

II. BACKGROUND

This section provides some common understanding for the terms used in the paper, looking at *theater*, *level of war*, *level of command*, *territory* and the *Global Information Network*, and *OOTW*, and then discusses sources. Some of these concepts, such as *theater* (of war, of operations, etc.), and whether a certain commander is operating at what *level*, have themselves been subject to lengthy discourses.

1. Theater. There are *theaters*, *theaters of war*, *theaters of operations*, *areas of operations*, and *areas of assistance*, among others. Theaters and areas are often related to levels of war and command organization. For our purposes, we are referring to Eisenhower's European theater, McArthur's Pacific theaters, Westmoreland's Vietnam, and Schwarzkopf's Desert Shield and Storm. These situations involved slightly different command relationships but had a single commander and staff in charge. We are also referring to the operations in Somalia and Grenada and Panama, where we had a joint operations area and theater campaign plan.

2. Level of War. The Joint Chiefs of Staff (JCS) recognize three levels of war: strategic, operational, and tactical [7], which are illustrated in Figure 1. The strategic level is split into national and theater to reflect significant and unique functions are performed at these two levels to achieve strategic purposes. These different levels of war represent different scopes, responsibilities, authorities, and perspectives, including perspectives on desired outcomes and MOEs. The analytical problems are at the seams: in this case, the theater strategic and operational levels, where the CINC and the JTF commanders do most of their business.

The level at which the commander operates is determined by the intent of the mission, corresponding to an echelon of command. The relationship between theater strategic and operational levels of war is important, but it is not the focus of our discussions, so we will move on.

We refer to the theater level of war as the top of the three levels in the *deployed* forces: Theater Strategic, Operational, and Tactical. Generally, CINCs conduct unified operations at the Theater Strategic level. It is becoming increasingly common for JTF commander conducting joint operations to find his actions cause him to accomplish similar tasks on behalf of the CINCs unified action.

3. Level of Command. In addition to CINCs, we address those JTF operations undertaken by forces directly subordinate to the CINC (the immediate subordinate echelon). JTFs can be established with any number of ranks, forces, missions, and levels. For our purposes, we focus on three-star JTF commands, built around Army Corps, Numbered Fleets, Numbered Air Forces, and Marine Expeditionary Forces. For an operation, one of these headquarters can be augmented with forces and staff from other Services to provide a joint capability. USACOM has proposed to train the three-star HQ to be JTF headquarters. In overseas areas, Service forces, subordinate unified commands, and standing joint task forces can comprise the JTF. US Commander in Chief, Pacific Command (CINCPAC), for example, uses a two-tier command and control (C²) system. In addition, specialized commands, such as the Joint Special Operations Command (JSOC) and the smaller Special Operations Commands in overseas theaters, can also operate semi-independently at the operational level. So, for our purposes, we include Joint Task Force commanders along with the CINC as our focal point.

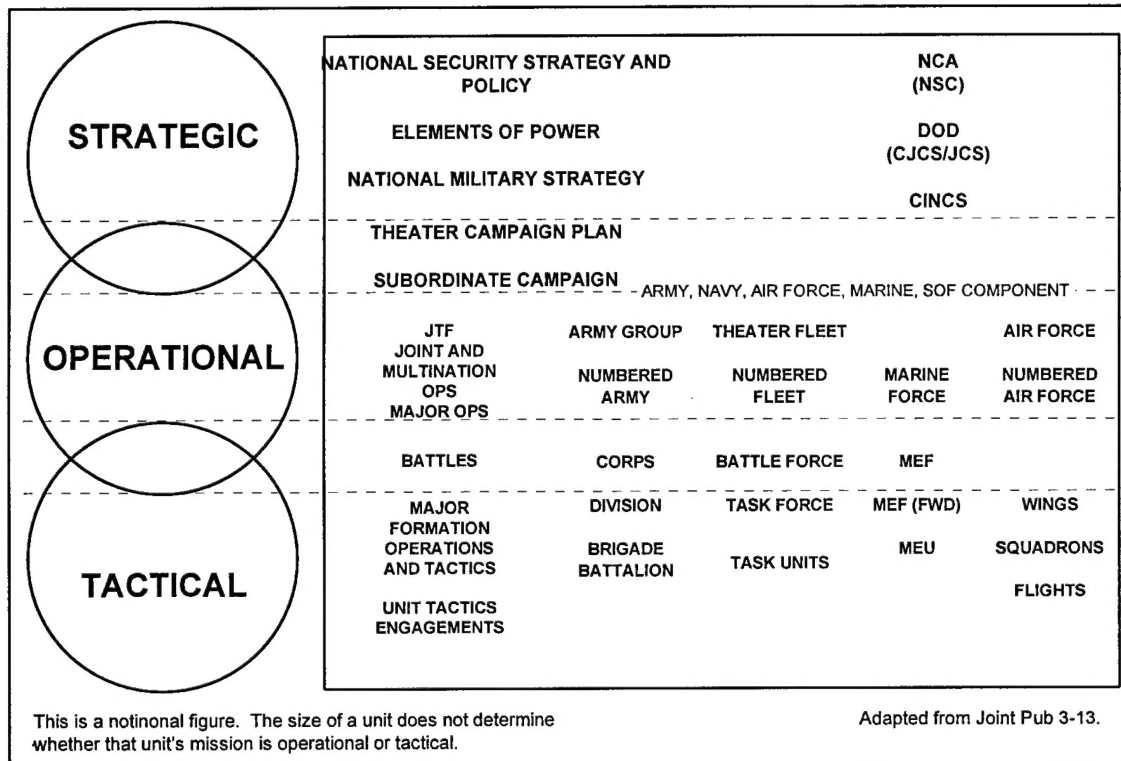


Figure 1. Three Levels of War

4. Territory and the Global Information Network. Territory gives a commander authority over forces and facilities included therein. More territory is not always good: it adds responsibilities for the protection of forces in potentially peripheral areas, which can dilute the commander's focus on those most important. The arrival of the Global Information Network has expanded the commander's playing field - whether he likes it or not.

5. Operations Other than War. If there is a new world order, it seems to include a large number of what is called (Military) OOTW. So-called conventional operations may be easier to contemplate, but we are encountering OOTW operations with increasing frequency and need to know how to measure their results. Virtually all US combat operations and OOTW will be joint, and many will be combined. This brings the possibility of drawing on all Services plus joint and allied assets to achieve the endstate of decisive victory, not to mention international agencies and Private Volunteer Organizations (PVOs), Non-governmental Organizations (NGOs), and Business International Non-governmental Organizations (BINGOs). If it is difficult to measure theater operations, and difficult to establish the contribution of IW to them, then perhaps it is even more challenging to try to do this within OOTW [1].

6. Sources. Joint doctrine, tactics, techniques, and procedures provide guidance for theater and JTF operations. Guidance on IW/C2W, through new or revised joint publications, is now under development. Also, we spoke to several authorities on theater-level operations at the National and Army War Colleges — although our presentation in no way should be interpreted as representing their official position. For theater-level operations, the question we had for the War Colleges was “how do you measure theater operations, and how can you tell if you achieved the national security objective: a win?” We found that they were working on the same issues. We were helped by a number of references, notably Larrabee's *Commander in Chief* [14], Puryear's *19 stars* [17], Perry's *4 Stars* [16], and Warden's *The Air Campaign* [22]. Clay Blair's *The Forgotten War* [2] provides an excellent look into theater and sub-theater operations. *The General's War* [10], just released by Gordon and Trainor, should prove interesting, if not

controversial. As this paper is going to press, we received "C3IEW Measures Workshop II," a *Phalanx* article [19].

III. INFORMATION WARFARE AND COMMAND AND CONTROL WARFARE

A number of terms used to describe our focus: Information War, Information Warfare, Information Operations, and Command and Control Warfare. For our purposes, consider that C2W is the military application of IW and is nested within IW. Some will say that IW is nothing new, there are new technologies to attack and new technologies to do it with, along with some new and imaginative combinations to use. The JCS has a definition of C2W; the Army coined the term Information Operations (IO) but now seems to be moving to the use of C2W [9]. Where appropriate, we will touch on the larger aspects of IW to include pre- and post-hostilities, the use of non- and less-than-lethal agents, and interagency operations.

Command and control warfare — The integrated use of operations security (OPSEC), military deception, psychological operations (PSYOP), electronic warfare (EW), and physical destruction, mutually supported by intelligence, to deny information to, influence, degrade, or destroy adversary command and control capabilities, while protecting friendly command and control capabilities against such actions. Command and control warfare applies across the operational continuum and all levels of conflict. Also called C2W. C2W is both offensive and defensive. (Definition from [11], deleting some comments).

Time and space limitations force us to restrict ourselves to offensive C2W (i.e., counter command and control) here, but we will mention the C2-protect aspect when it fits in naturally. Our emphasis is on taking down the enemy's ability to command and control his forces in the field and the links from those forces to his national command authorities establishment, while protecting our C2 from similar attacks. Before measuring the effects of our C2W programs, we need to determine the contribution of C² to military operations, at theater or other levels. We know military formations require C², but establishing a quantified value, or even an expert guess, relative to the more traditional forms of combat power has been difficult.

We are entertaining projects with significant expense to our C² and C2W Research, Development, and Acquisition (RD&A) budget. The digital battlefield, common situational awareness, and seamless architectures, all are quite expensive and we need some way to assess relative values of competing programs. To really assess the worth of C2W, it must be included in a full-up combat simulation at theater level. There is a real need for this capability and we have developed some ideas in this paper on how to achieve it.

IV. WHEN AND HOW TO MEASURE THEATER OPERATIONS

For some purposes, and in some situations, a forward edge of battle area (FEBA) trace or a body count will suffice for battle damage assessment (BDA). However, when conducting theater-level operations, we really should go beyond the FEBA trace and killer-victim scoreboard mentality. At this level, there is not necessarily an abundance of quantifiable measures. Determining C2W results appears to be a fuzzy, subjective process. Thus, when considering C2W MOEs, we have to look for *indicators* that suggest success or failure.

Some measures are most appropriate at certain times. For example, the calculation of reinforcement requirements is most critical during the planning stages, although it continues throughout the campaign. Other measures, such as divining the impact of C2W as a separate component of the

operation, may require information (i.e., the enemy commander's attitudes and beliefs) that is not available, certainly during the battle and most often afterwards. Following are some thoughts on these areas:

1. When to Measure. Important details for MOE need to be captured throughout the eight stages of force projection, to include the assessment, planning and preparation phases, the conduct of operations, and the important (but often neglected) termination and redeployment phases.

2. How to Measure: The Tools. Historical analyses, refining the lessons of past operations, have produced a body of policy and doctrine. While doctrine is guidance rather than directive, deviation is at the risk of the commander. The use of simulations, war games, and seminars is increasing, even during the conduct of operations. Advanced decision support tools and models are now found in field combatant headquarters. Finally, after action reviews and even boards of inquiry are occasionally conducted. These dependent on the collection and organization of data during the operation, and feed the military's lessons learned files and remedial action programs.

3. Objective and Subjective Measures. We tend to be comfortable with objective measures, and these have an important role to play in theater operations. Wherever it makes sense to do so, we want to identify important quantifiable things, link them to conditions that exist, calculate results, and measure them against expectations or standards. However, if we cannot count something in a meaningful sense, do the results count towards success? We think they do. There are a number of techniques such as Multi-Attribute Decision Analysis, panels of experts, and professional military judgment to support subjective measures. Most helpful is the Reflective Practitioner approach, where people who are expert in certain areas use subjective judgment, assisted, where they deem useful, with objective data.

V. THEATER-LEVEL MOE WORKSHEET

We need some structure for the development of theater MOEs. While some excellent work has been done on lower-level operations [3, 19, 20], theater-level MOEs seem to require information that is usually subjective in nature; hence, some newer approaches might be helpful. Some key elements we must consider when designing a measurement scheme for theater level operations are listed in Figure 2.

THEATER LEVEL MOE WORKSHEET
MOE NAME/IDENTIFIER:
STATEMENT:
RELATED MOEs:
SIGNIFICANCE:
DATA REQUIRED FOR MOE:
BLUE INFORMATION/INTELLIGENCE SOURCES:

Figure 2. Theater Level MOE Worksheet.

First is the short *name identifier*, or label, of the MOE. Next is a full *statement* of the MOE. Because a number of these MOEs are closely associated, we next list those MOE that are *related*, and some form sets, which could become parts of a campaign. We want to do in combination and synchronization, so relatedness is helpful. The *significance* entry provides the reason why we have

selected this MOE. Each MOE requires the collection or generation of *data* for evaluation, so some sources are listed in the next portion of the worksheet. Most of these MOEs can be turned around to describe what the enemy will try to do to us. Hence, they provide a useful statement of our C2-protect challenges.

Some Worksheet Examples. We have provided examples of the worksheet technique. Our first example, shown in Figure 3, is an important one: whether and when Blue determined the location and time of the enemy's main effort, attack or defense, is determined.

THEATER LEVEL MOE WORKSHEET
MOE NAME/IDENTIFIER: Determine Enemy Main Effort
STATEMENT: Did Blue identify the enemy's main effort? If so, when?
RELATED MOEs: <ul style="list-style-type: none">• Did Blue detect any changes in Red main effort? If so, when?• Did Blue affect these locations through IW?• Was Blue C² deceived by Red on these issues?
SIGNIFICANCE: High quality Blue intelligence should provide the probable location of the enemy main effort and detect changes therein. If Blue can read the Red plan, especially where and when the main effort will be made, Blue forces can be positioned, in time, to blunt a Red attack or take advantage of the best Blue offensive options. If this intelligence is available early in the prehostilities phase, Blue may be able to conduct IW operations to influence the attack decision by Red. Blue counter deception screening should preclude Red deceiving Blue on these locations and times.
DATA REQUIRED FOR MOE: <ul style="list-style-type: none">• Actual location of enemy main effort (when known).• Blue decision on perceived location of enemy main effort.• Change of location in enemy main effort (if any).• Time that enemy made these decisions.• Time that enemy conducted observable force movements.• Time Blue concluded that enemy effort was in certain location.
BLUE INFORMATION/INTELLIGENCE SOURCES: <ul style="list-style-type: none">• Imagery.• Sensors (air, ground, battle reports).• COMINT, ELINT, SIGINT, MASINT, HUMINT.

Figure 3. MOE Worksheet for Determine Enemy Main Effort.

Theater intelligence operations should identify the enemy's main effort. Blue needs to determine where the enemy will make his main offensive and defensive efforts. Time is of the essence since Blue will have to deploy forces to blunt the Red thrust or bypass Red strength in Blue offensive operations. If major changes in the threat plan are made after the battle begins, they also should have been picked up by the intelligence process. Both sides will be reacting to intelligence and assessments, some of which

will be wrong. Since both sides will be conducting C2W, the availability, quality and reliability of information/intelligence will be affected. Errors will be made in the intelligence fusion process; commanders will have to evaluate risk associated with selection of courses of action and will inevitably provide hedges against intelligence failures. Timing is critical for both assessments and actions. It is important not only to make the right decisions, but to do so in a timely fashion. Multiple intelligence sources will provide information and indications which must be screened for deception operations by the enemy and then fused.

Let us examine another MOE, shown in Figure 4, trying to determine whether Blue exploited a one sided advantage in a major mode of warfare.

Assume that Blue has complete dominance or a highly favorable ratio of air power or overhead imagery. We would expect Blue to use this to its maximum advantage, even to the extent of extending a phase of the campaign (e.g., initial air operations) beyond the initial time line. An indicator would be whether Blue was bound to a plan or was capable of recognizing and fully exploiting an advantage. Advantages often are not evident prior to hostilities; most will appear during the operation and must be recognized, evaluated, and exploited as appropriate.

The discovery, creation, or creation of the appearance of asymmetrical advantages is a critical step during the planning and preparation phases. In some cases, it can make the difference on whether, when, where, and how to initiate operations. Rules of Engagement (ROE) are an important consideration; restrictive ROE can preclude the exploitation of a significant advantage. For this reason, the development, modification, and negotiation of ROE is a critical activity, the more so in combined operations. This type of measurement is difficult to make during the operation, but it is a continuous process. Post-operations analyses should provide sufficient data for the comparison.

It is incumbent that the Blue force not gain a pyrrhic victory and that it remain a capable force during each phase, to include termination of hostilities. The degree to which this is achieved is an important measure with implications all the way back to the force development in peacetime. For example, in some cases, Blue advantages in high technology systems may be limited by the ability to buy in numbers of these munitions and systems.

THEATER LEVEL MOE WORKSHEET

MOE NAME/IDENTIFIER: Blue Exploitation of Asymmetrical Advantages

STATEMENT: Were asymmetrical operations (exploiting friendly strengths against threat weaknesses) employed?

RELATED MOEs:

- Were Blue asymmetrical weaknesses protected against enemy strengths?

SIGNIFICANCE: Blue may have a significant or unilateral dominance in a major element such as satellite assets or air power. This advantage should be fully exploited in the campaign, subject to Rules of Engagement.

DATA REQUIRED FOR MOE:

- Red-Blue force comparisons of major combat strengths (maneuver, air, naval, SOF, intelligence, EW, air defense, etc.)
- Calculated asymmetrical advantages.
- Determination of whether Blue correctly assessed advantages.
- Comparisons of before and after strengths of major combat force elements.

BLUE INFORMATION/INTELLIGENCE SOURCES:

- Red and Blue order of battle, before and after battle.
- Battle journals and reports.
- Third party reports.
- Comparison of actual enemy strengths over time with Blue estimates.
- Influence of Red C2W on Blue estimates and vice-versa.
- Communication intercepts.
- Strategic intelligence assessments.
- Sensors (air, ground).
- ROE, Blue and Red.

Figure 4. MOE Worksheet for Blue Exploitation of Asymmetrical Advantages.

During the assessment phase of the campaign, we would determine which side has which advantages based on intelligence. During the campaign itself, we would expect to see a high level of activity of the Blue modality. At the end, we would expect to see significant battle results attributable to this modality and a very low or non-existent Red level of activity in this modality.

Our next example, provided in Figure 5, deals with the important area of reinforcements for the forward deployed force.

THEATER LEVEL MOE WORKSHEET

MOE NAME/IDENTIFIER: Reinforcements

STATEMENT: Were reinforcement requirements correctly calculated, requested, deployed, and located in a timely manner, and were they of the correct type?

RELATED MOEs:

- Did Blue properly estimate the resources and time it would take to conduct the operation?

SIGNIFICANCE: With limited forward deployed forces, reinforcements (in virtually all cases) will have to be deployed to, and then within, areas of probable employment. The process begins with the assessment phase, when Red forces, mission, and many other factors are weighed to compute the Blue forces necessary for a quick and decisive victory. If sufficient forces cannot be built up in the objective area, an operation may be delayed or canceled. Problems arise when an operation changes character during its conduct, causing planned Blue forces to be inadequate or inappropriate.

DATA REQUIRED FOR MOE:

- Red-Blue force comparison data available to Blue planners.
- Actual Red-Blue force comparison at onset of hostilities.
- Planned timing and location of Blue reinforcements.
- Optimal location and availability of Blue reinforcements.
- Actual location and arrival of Blue reinforcements.
- Comparison of Blue perception and actual Red situation at critical times.

BLUE INFORMATION/INTELLIGENCE SOURCES:

- Blue strategic preparation of the battlefield estimates.
- Actual Red situation and force data.
- Blue decisions on priorities among multiple theater requirements.

Figure 5. MOE Worksheet for Reinforcements.

In this MOE, we deal with the planning for major combat forces and high technology systems (i.e., "silver bullets") to deploy and position for employment at critical junctures in the campaign. During the planning and preparation phase, Blue is making a constant estimate of Red intentions, strengths, locations, and timing. National and theater intelligence systems will have to be marshaled to support these estimates. When Blue forces are committed to more than one contingency, trade-off choices on forces and systems will have to be made between theaters. The decision to initiate operations, and particularly at what level, or type of operations, has to be made. Red, in almost all cases, will attempt to conceal time and location of attack, a concealment which Blue must penetrate. Once operations commence, Blue reinforcements will be moved by strategic mobility assets to positions within the theater. Blue wants the right kind of forces, at the right place, and at the earliest time. The concealment of the major attack locations is critical to the enemy's success and will be supported by a concerted C2W effort. MOEs, using Subject Matter Expert judgment, will review whether Blue was optimally positioned with sufficient forces to achieve success.

Let us consider how we might generate some analytical data without actually going to war. In simulations, the Time Phased Force Deployment List (TPFDL) will bring the forces into position at selected times. If a strategic mobility module is included, we could find delays and rerouting based on mobility factors. Depending on the degree to which terrain and transport nets are played, we would have a calculation of force movement that could differ from the initial plan. This would be more interesting if lines of communication, strategic or theater, were subject to interdiction. Calculation of force ratios at

critical junctures in the simulation could provide a comparison of whether initial estimates were valid. Endgame calculations could relate reinforcements' impact on the success (or failure) of the campaign plan.

At DRC, we are working our way through a large number of these measures; the examples provided here are intended to illustrate our premises. Thus far, we have examined three MOEs utilizing our worksheet approach and more than two dozen MOEs are provided at the annex in a still growing list. Most of C2W is poorly modeled. There is a reason for this: C2W is very complex with its inclusion of other concepts such as destruction, PSYOP, deception, EW, and OPSEC. It is difficult to isolate the unique contribution of C2W. With that in mind, we offer some thoughts intended to improve abilities in this area.

VI. MODELING AND SIMULATION OF IW/C2W

1. Dynamic Model Preference. We admit to a preference for dynamic over static ratio analyses. This subjects the things we are measuring to the ever-changing dynamic context of battle. Decisions of a force are made in a context based on incomplete and erroneous information, under the stress of time, battle, and fatigue. Success is based on a continuously fluctuating assessment and measures must accommodate this.

2. Theater and operational level models. Any war exists as an envelope of possibilities. Models help define points on the envelope. Theater models that ignore IW, logistics, etc., however, define only a small portion of the envelope. Several models and simulations exist, but few provide significant coverage of joint operations and echelons above corps. There is a good reason for this. Theater operations with their joint and combined forces, are quite complex and controversial, the latter when the relative impacts of Services, systems, and terrain interject the rivalries we see among the actors. However, not one does a good job reflecting C2W within the context of a force-on-force, theater-level, perception-driven decision model. For this reason, we often see lower-level models, such as Corps Battle Simulation (CBS) being used, supplemented by extensive man-in-the-loop play.

3. C2W Models. Currently, no integrated models and simulations appear to address the full scope of C2W as described in the JCS definition presented earlier. Some models and simulations, however, are useful when considering separate aspects of C2W. For instance, although they do not incorporate the interaction of large formations in combat, several EW and communications models can be used to support aspects of the C2W big picture. Building a model whose breadth and depth are designed to richly depict the full scope of C2W at the theater level would be an ambitious undertaking. Such a model, though, would be a potent tool, particularly if it allowed one to isolate results attributable to C2W from those of the entire operation. A set of relevant models appears in Annex B.

VII. IMPROVEMENTS FOR THEATER LEVEL C2W MOE

We need better tools to measure the theater campaign, and the portion thereof attributable to IW/C2W. This will not be trivial since the conduct of IW/C2W is increasingly difficult to isolate from other operations. These synergistic activities are much more than EW. They are a new way of thinking about combat operations and they require a new paradigm for the conduct thereof. As a result of our work to date, several ideas for improvements have emerged and are discussed below.

1. Derive IW/C2W objectives from the theater operation, and relate these together so the degree of their attainment can be measured.

2. Improve and accept subjective appraisal techniques. A blend of subjective appraisal techniques is required for theater-level campaign analyses, using objective techniques when available.
3. Theater-level operations require better simulation tools. Though specialty models are valuable, they do not reflect the shifting nature of combat as portrayed in a multiechelon, dynamic force-on-force model. We must build models that adequately portray the combat and major supporting activities of a theater operation, to include a detailed laydown of the aspects of C2W. Constructing a model whose breadth and depth are designed to richly depict the full scope of C2W at the theater level would be an ambitious undertaking. Such a model, though, would be a potent tool and is required.
4. Develop perception management concepts, utilizing all aspects of information warfare, to destroy the effectiveness of enemy commands. Investigate how adversary commanders' Observation–Orientation–Decision–Action loops [4] can be disrupted and develop analytic techniques for assessing the efficacy of such disruptions.
5. A perception-based decision model that records decision traces is needed to fully evaluate perception related MOEs. Alternately, constructive simulations with man-in-the-loop can be used to produce the information required for the evaluation.
6. Collect, analyze, and disseminate intelligence — and model this process. Timely and thorough intelligence is an essential prerequisite for measuring C2W, as well as conducting it.
7. Make commanders knowledgeable of the power of IW/C2W so they are as skilled in the employment of these as they are with maneuver and fires. So doing will require an investment in the military education field.

VIII. CONCLUSIONS

How do you define a “win” in theater operations, how do you determine the extent to which C2W contributed? This is quite similar to the vexing question posed several years back in [1], a fascinating piece asking how a win was defined in Low Intensity Conflict (LIC). Defining a theater win and C2W's contribution to that win, like the LIC issue, are difficult to quantify and require subjective judgment. We need MOEs so we can learn from both our successes and our failures. Thus, this paper represents an attempt to provide some techniques for thinking about MOEs at the theater level.

C2W and IW are important to what we are doing and need to be within the emerging paradigm of US forces operations. Hopefully, the field will flourish with new and imaginative combinations of new and old technology. And hopefully, it will not suffer from false premises, overblown promises, or the fear of old time warriors who are afraid to learn new tricks or at the least allow others to do so. C2W has shown promise as a valuable force multiplier, and by analyzing MOEs for C2W at the theater level, we can best fathom and refine its promise.

IX. ACKNOWLEDGMENTS

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ANNEX A: Theater-Level MOEs

Listed below are several MOEs that are interesting from the theater-level and show potential for C2W measurement; a subset of these were addressed in more detail in the paper's body. Note that this list of MOEs, which is by no means exhaustive, is still under development¹.

1. Did Blue seize opportunities for offensive action? Did Blue select the best offensive avenue of approach? Did Blue chose the most favorable defensive terrain?
2. How well did Blue "read" the threat plan? Was Red's main effort predicted and, if so, how timely was this prediction? Did Blue detect major changes in threat plans and campaign strategy in a timely manner?
3. Were significant modalities (i.e., air, air defense, C4I) defeated on either side?
4. Did Red reach its culminating point? Did Blue?
5. Were branches and sequels foreseen? Was there adequate preparation?
6. Did Blue detect third parties entering the conflict on Red's behalf?
7. Did Blue defeat the enemy's strategy or plan, or did a slugfest ensue?
8. Did Blue locate Red's center of gravity in a timely manner? Did Blue defeat Red's center of gravity?
9. Did Blue properly estimate the resources and time it would take to conduct the operation, given the plan?
10. Did Blue get reserves to the theater in time? Were they in the proper location and posture when needed?
11. Did Blue identify Red's main thrust? If so, was it identified with sufficient time to react?
12. Did Blue exploit asymmetrical advantages?

¹Readers with comments or suggestions about these or other MOEs are encouraged to contact the authors.

13. Did Blue thwart Red from developing potential asymmetrical advantages or, if already present, deny Red their benefits?
14. Was Blue's mission from political leaders clear and unequivocal? Was it attainable?
15. Did Blue convince the enemy of defeat?
16. How high were Blue casualties, in both absolute and relative numbers?
17. Did Blue have a plan to terminate operations and get out of the area? Was this plan successful?
18. Were appropriate ROE issued and honored?
19. Was the flow of important message traffic impeded? Was priority message subject to saturation?
20. Were critical communication nets and nodes interrupted significantly? Were interruptions introduced at critical times?
21. Was interception of message traffic successful?
22. Was critical information and intelligence collected and analyzed? Was it disseminated in a sufficient and timely manner to command levels needing the information?
23. Were critical decisions made on faulty data and reports?
24. Were major force deployments made based on incorrect perceptions?
25. Was Blue's phasing of the campaign or operation properly planned and executed?
26. Were Blue force components maintained in a balanced fashion, as opposed to unequal attrition to a marked and unnecessary degree?
27. Did Blue establish theater boundaries of a size that permitted the JFC to control essential forces and territory without excessive responsibility for non-essentials?
28. Were allied coalitions maintained during the conflict? Were enemy coalitions fragile or broken?

ANNEX B: Model and Simulation List

Battlefield Surveillance Electronic Warfare Analysis Model (BASEWAM) is used to analyze ground and airborne target acquisition, surveillance, EW, and C³ systems and processes in realistic countermeasures environments. It simulates complete division/corps-sized systems to the individual component/platform level, determines total system requirements, and measures system vulnerability, performance and effectiveness.

Command and Control Decision Aid (C2DA) is used to assess the likelihood of an adversary's intent of pursuing a specific course of action.

Command, Control, and Communications Evaluation Model (C3EVAL) is designed to simulate the interaction of message traffic between communications nodes and ongoing combat based on C2 rules with the overall goal of assessing the function of C² in terms of combat outcomes. C3EVAL generates a set of interactions from which to judge the effectiveness of C³ architectures in directing weapons systems.

Intelligence/Electronic Warfare Model (IEW) is an operational support tool used to evaluate the capability of proposed IEW systems, to receive and process specified levels of message traffic, and to evaluate the performance of sensor systems.

Intelligence Processing Operator Workstation Model (IPOWS) is used for evaluating the capability and performance of IEW processing systems. It emulates the flow of messages from sensor assets through communications relays to the intelligence production cells at division and corps.

Joint C3 Simulation (JC3S) deals with system development and effectiveness, providing representative modeling of air and land component forces, terrain features, and their interactions.

Joint Electronic Combat Electronic Warfare Simulation (JECEWSI) is an exercise driver for Command Post Exercises (CPXs) designed to focus on the electronic combat environment in support of tactical air and air defense operations. This model quantifies the effects of EW systems on the outcome of training scenarios.

Joint Force Analysis Model/Electronic Warfare (JFAM/EW) focuses on the electronic combat environment in support of tactical ground and air operations. JFAM/EW analyzes communications, EW, and air defense employment concepts; assesses system/force mix; examines Interoperability issues; conducts combat and support force trade-offs; examines joint and combined warfare issues; and interfaces with field test excursions.

Sensor Interaction Model (SIM) characterizes the performance of individual or suites of sensors against specific threat scenarios.

SIGINT Analysis and Simulation System (SASS) is a research and evaluation tool for analyzing of current and projected signal environments and current and future sensor systems operating in those environments.

Stand-Off Jamming (SOJ) evaluates the Electronic Counter Measures (ECM) effectiveness of a stand-off jammer screening a penetrating aircraft against ground-based radars.

SPECT8/CIMUL8 is used to support systems requirements definition as well as system effectiveness and survivability. Operating in the space, air, ground, or sea based domain, it models weapons systems, sensors, communications systems, and/or jammers.

Suppressor is a tool for evaluating different weapon systems, sensor systems, and tactics or command procedures in composite electronic combat missions against an integrated air defense.

Tactical Simulator (TACSIM) supports intelligence and electronic warfare (IEW) development and testing, as well as evaluations of IEW and C³ functions.

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